

## ABSTRACT

A silicon single crystal rod (24) is pulled from a silicon melt (13) molten by a heater (17), and a change in diameter of the silicon single crystal rod every predetermined time is fed back to a pulling speed of the silicon single crystal rod and a temperature of the heater, thereby controlling a diameter of the silicon single crystal rod. A PID control in which a PID constant is changed on a plurality of stages is applied to a method which controls the pulling speed of the silicon single crystal rod so that the silicon single crystal rod has a target diameter and a method which controls a heater temperature so that the silicon single crystal rod has the target temperature.

A set pulling speed for the silicon single crystal rod is set so that V/G becomes constant, and an actual pulling speed is accurately controlled so as to match with the set pulling speed, thereby suppressing a fluctuation in diameter of the single crystal rod.

## (12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関  
国際事務局(43) 国際公開日  
2004年3月4日 (04.03.2004)

PCT

(10) 国際公開番号  
WO 2004/018742 A1(51) 国際特許分類<sup>7</sup>: C30B 29/06, 15/26, H01L 21/208

SILICON CORPORATION) [JP/JP]; 〒105-8634 東京都 港区 芝浦1丁目2番1号 Tokyo (JP).

(21) 国際出願番号: PCT/JP2003/008577

(72) 発明者; および

(22) 国際出願日: 2003年7月7日 (07.07.2003)

(75) 発明者/出願人(米国についてのみ): 若林大介 (WAKABAYASHI,Daisuke) [JP/JP]; 〒105-8634 東京都 港区 芝浦1丁目2番1号 三菱住友シリコン株式会社内 Tokyo (JP). 斎藤正夫 (SAITO,Masao) [JP/JP]; 〒105-8634 東京都 港区 芝浦1丁目2番1号 三菱住友シリコン株式会社内 Tokyo (JP). 佐藤智 (SATO,Satoshi) [JP/JP]; 〒105-8634 東京都 港区 芝浦1丁目2番1号 三菱住友シリコン株式会社内 Tokyo (JP). 古川純 (FURUKAWA,Jun) [JP/JP]; 〒105-8634 東京都 港区 芝浦1丁目2番1号 三菱住友シリコン株式会社内 Tokyo (JP). 北村浩之介 (KITAMURA,Kounosuke) [JP/JP]; 〒

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

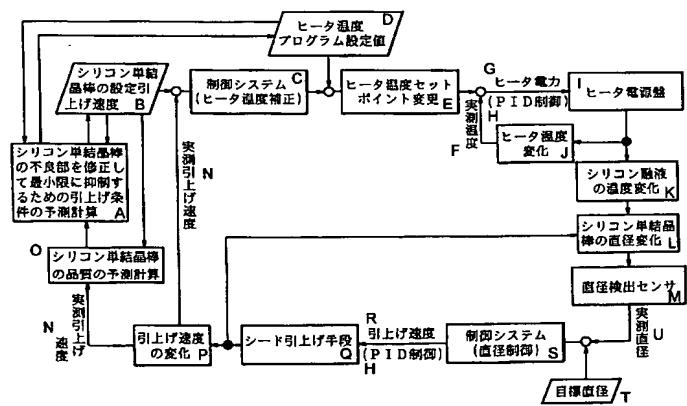
(30) 優先権データ:  
特願2002-197140 2002年7月5日 (05.07.2002) JP

(71) 出願人(米国を除く全ての指定国について): 三菱住友シリコン株式会社 (SUMITOMO MITSUBISHI

[続葉有]

(54) Title: METHOD OF PRODUCING SILICON MONOCRYSTAL

(54) 発明の名称: シリコン単結晶を製造する方法



A...ESTIMATION CALCULATION OF PULL-OUT CONDITIONS TO MINIMIZE DEFECT OF SILICON MONOCRYSTAL ROD BY MODIFYING IT  
 B...PRESET PULL-OUT SPEED OF SILICON MONOCRYSTAL ROD  
 C...CONTROL SYSTEM (HEATER TEMPERATURE COMPENSATION)  
 D...HEATER TEMPERATURE PROGRAM PRESET VALUE  
 E...CHANGE OF HEATER TEMPERATURE SET POINT  
 F...MEASURED TEMPERATURE  
 G...HEATER ELECTRIC POWER  
 H...PID CONTROL  
 I...HEATER POWER SOURCE BOARD  
 J...HEATER TEMPERATURE VARIATION  
 K...VARIATION IN MELTED SILICON LIQUID TEMPERATURE  
 L...VARIATION IN SILICON MONOCRYSTAL ROD DIAMETER  
 M...DIAMETER DETECTION SENSOR  
 N...MEASURED PULL-OUT SPEED  
 O...ESTIMATION CALCULATION OF QUALITY OF SILICON MONOCRYSTAL ROD  
 P...VARIATION IN PULL-OUT SPEED  
 Q...SEED PULL-OUT MEANS  
 R...PULL-OUT SPEED  
 S...CONTROL SYSTEM (DIAMETER CONTROL)  
 T...AIMED DIAMETER  
 U...MEASURED DIAMETER

(57) Abstract: A silicon monocrystal rod (24) is pulled out from melted silicon liquid (13) melted by a heater (17), and variation in the diameter of the rod at predetermined time intervals is fed back to a pull-up speed of the rod and to a heater temperature to control the diameter of the rod. PID control is applied to a method for controlling a pull-out speed of a silicon monocrystal rod so that the rod has an aimed diameter, and to a method for controlling a heater temperature so that the rod has an aimed diameter, and a PID constant is varied in plural steps in each of the methods. When a preset pull-out speed of a silicon monocrystal rod is set so that V/G is constant, and an actual pull-out speed is controlled with high accuracy so that the actual pull-out speed corresponds to the preset pull-out speed, the diameter of the silicon monocrystal rod is prevented from varying.

WO 2004/018742 A1

[続葉有]